CLAIMS

1. A method for ultrasonic inspection of welds (1, 50), more particularly welds (1, 50) joining two metal workpieces (2, 3; 51, 52) edge to edge, in which, to inspect the joint (1, 50):

a) applying the TOFD technique, at least one pair of transducers, formed from a first transducer (5) and a second transducer (6), one emitting ultrasonic waves and the other receiving ultrasonic waves, is moved in the longitudinal or circumferential direction along the weld (1) to be inspected, said transducers (5, 6) being positioned laterally on either side of the joint (1) to be inspected and said transducers (5, 6) comprising piezoelectric crystals or ceramics, so as to detect any flaw in the joint (1, 50) located at a depth of at least 5 mm; and

b) applying the incline-longitudinal wave or creeping wave (CW) technique, at least one third transducer (57, 53, 54, 55) is moved along the weld (1) to be inspected so as to detect any flaw in the joint (1, 50) located at a depth of between 0.5 and 15 mm.

2. The method as claimed in claim 1, characterized in that, at step a), the first and second transducers (5, 6) comprise piezoelectric crystals or ceramics of rectangular or oblong shape (24).

3. The method as claimed in either of claims 1 and 2, characterized in that, in step a), the ultrasonic transducers (5, 6) have a frequency band greater than 60% of the central frequency and a frequency between 1 and 20 MHz, preferably between 6 and 18 MHz.

4. The method as claimed in one of claims 1 to 3, characterized in that it includes the lateral shift (D)

of the pair of ultrasonic transducers (5, 6) relative to the center or axis of the weld (1, 50).

5. The method as claimed in one of claims 1 to 4, characterized in that, in step a), any flaw in the joint (1, 50) located at a depth of at least 10 mm, preferably between 10 and 300 mm and even more preferably 10 to 60 mm is detected.

6. The method as claimed in claim 1, characterized in that, in step b), the CW technique is implemented by injecting sound into at least part of the joint (1, 50) to be inspected with longitudinal sound waves inclined at an angle (β) of between 70 and 90º, preferably about 76º of angle of refraction, and/or at a frequency of between 1.5 and 4 MHz, in particular around 2 MHz.

7. The method as claimed in either of claims 1 and 6, characterized in that step b) is carried out in succession on each side of the weld (1, 50) to be inspected.

8. The method as claimed in one of claims 1, 6 and 7, characterized in that, in step b), any flaw in the joint (1, 50) located at a depth of between 0.5 mm and 20 mm, preferably 0.5 mm to 10 mm, is detected.

9. The method as claimed in one of claims 1 and 6 to 8, characterized in that, in step b), at least one third transducer (57, 53, 54, 55) is used, said transducer comprising a wave-emitting ceramic (53) allowing sound waves to be emitted in the direction of the weld (1, 50) and an ultrasonic wave receiving ceramic (54) for receiving ultrasonic waves.

10. The method as claimed in one of claims 1 to 9, characterized in that it includes a calibration phase in which the pair or pairs of ultrasonic transducers (5, 6) are calibrated on the basis of a calibration

notch of defined depth, simulating a crack, preferably a notch with a length of about 10 mm and a depth of around 1 mm.

11. The method as claimed in one of claims 1 to 10, characterized in that it includes at least one analysis step in which at least one signal received by the or each receiving transducer is analyzed, while the weld (1, 50) is being scanned, so as to detect any flaw, especially any crack (34), and preferably to determine or evaluate the depth or length thereof.

12. The method as claimed in one of claims 1 to 11, characterized in that the thickness (e) is between 5 mm and at least 60 mm, and the workpieces are walls of equipment or components operating under pressure, forming part of chemical or petrochemical units, nuclear power stations or the like, structures of flying machines, elements or components of rotating machines, pipes, railroad rails or any other all-welded assembly.

13. An apparatus for implementing the method of inspection of welds as claimed in any one of claims 1 to 12, characterized in that it comprises:

- at least one pair of transducers formed from first and second transducers (5, 6), one emitting ultrasonic waves and the other receiving them, said transducers (5, 6) using piezoelectric crystals or ceramics (24) and the two transducers (5, 6) being mechanically linked via a common support (7) that holds them in place at a certain distance (E) apart, and also being connected to a liquid, in particular water, inlet (15, 30 to 33) for acoustic coupling of these transducers (5, 6) with the element (1, 2, 3) to be inspected;
- at least one third transducer (57, 53, 54, 55); and

- processing means (8) for processing the measurements, the transducers still being connected to said measurement processing means (8).

14. The apparatus as claimed in claim 13, characterized in that the common support (7) for the two transducers (5, 6), one an ultrasonic wave transmitter and the other an ultrasonic wave receiver, comprises a rod linkage system (16, 17) designed to allow the gap (E) between these two ultrasonic transducers (5, 6) to be adjusted.

15. The apparatus as claimed in claim 14, characterized in that the rod linkage system (7; 16, 17) for supporting the two ultrasonic transducers (5, 6) also includes a pivoting arrangement for pivoting (about axes 19, 20) each transducer (5, 6), with locking means (21, 22) for locking them in a chosen angular position.

16. The apparatus as claimed in one of claims 13 to 15, characterized in that the common support (7) for the two ultrasonic transducers (5, 6) possesses an arrangement allowing the pair of transducers (5, 6) to undergo a lateral shift (D) relative to the center of the weld (1) to be inspected.

17. The apparatus as claimed in claim 13, characterized in that said third transducer (57, 53, 54, 55) comprises a wave emitting ceramic (53), allowing sound waves to be emitted, and a sound wave receiving ceramic (54), allowing sound waves to be received.